

Driving Distance on the PGA and LPGA Tours, 1993-2012

In this paper I examine driving distance on the PGA and LPGA tours, 1993 to 2012. I use piecewise regression to identify separate periods of change in the annual average driving distance - year relationship. These are: 1993 – 1999, 1999 – 2000, 2001 – 2003, and 2003 – 2012. I argue that improvements in the driver in the 1990s are primarily responsible for the increase in driving distance in the first period and that the limitations placed on the trampoline effect of the driver face for 1999 by the USGA effectively ended the distance premium from new driver technology. Then, in 2001, the introduction of the three piece ball resulted in additional gains in driving distance until changes in testing procedures in 2003 enabled the USGA to more effectively control golf ball distance. The faster swinging men pros benefited more from the three piece ball than did the women in terms of driving distance, while each benefited equally from the improved driver technology. Fixed effect estimates indicate that there has been some crowding out of shorter drivers by longer drivers on the tours since 1993.

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Introduction

Between 1980 and 1993 the average driving distance on the PGA Tour increased three yards, from 257 to 260 yards. Over the next 10 years, the average driving distance increased 27 yards, reaching 287 yards in 2003. Since 2003 there has been only a small increase in driving distance. Average driving distance on the Ladies Professional Golf Association Tour increased 22 yards, 1993-2003, and also leveled out in subsequent years. In this paper I conclude that most of the increase in driving distances, 1993-2003, can be attributed to technological improvements in the golf driver and golf ball. There is evidence of player fixed effects which reduce the rate of increase in distance in the period and indicate that longer drivers have crowded out shorter drivers on the tours since 1993. I argue that improvements in the driver in the 1990s are primarily responsible for the increase in driving distance in this decade and that the limitations placed on the trampoline effect of the driver face for 1999 by the USGA effectively ended the distance premium from new driver technology. Then, in 2001, the introduction of the three piece ball resulted in additional gains in driving distance until changes in testing procedures in 2003 enabled the USGA to more effectively control golf ball distance. The faster swinging men pros benefited more from the three piece ball than did the women in terms of driving distance, while each benefited equally from the improved driver technology. I investigate these issues using data for PGA tour and for the LPGA tour, 1993-2012.

There has been substantial research on the importance of driving length and accuracy on the PGA Tour. Brodie (2012) uses the 8 million strokes in the PGA shot link data from 2003 to 2010 to estimate shots gained or lost relative to the average result on tour for each stroke, based on the location characteristics of the starting and ending points of the shot (tee, fairway, rough, sand, recovery, or green) and distance to the pin at each location. His table 1 results show that two thirds of the stroke advantage enjoyed by top ten golfers in the period was due to their proficiency relative to their peers in shots over 100 yards. For bottom 10 golfers in the period, an even greater proportion of their scoring disadvantage was due to their deficiency in the long game relative to their peers. Thus, it was the long game, not the short game, that was most important to success on the PGA tour. Brodie's table 2 results show that almost one half of the over 100 yard shot advantage for the top players was from the drive as compared to approach shots from over 100 yards. This finding is in contrast to the results from a number of studies that use the website PGA tour and LPGA tour data. They do not find driving distance and driving accuracy to be as important as the shot link data show in explaining scoring or earnings. Explanatory variables in these studies include annual average measures for each player of driving distance on two holes,

driving accuracy on all holes but par 3s, greens in regulation, putting average on holes reached in regulation, and sand saves. Findings include, “these results indicate that putting is the most significant skill factor (Peters 2008).” And “it still remains true that putting ability is still by far the single most important determinant of earnings (Alexander and Kern, 2005).” And “these findings indicate a remarkable stability in terms of the relative importance of greens in regulation and putting average in explaining the variability in scoring average (Wiseman and Chatterjee, 2006).” Similarly, “the analysis shows a high greens in regulation percentage and a good short game are the keys to low scoring averages and high earnings. This is no surprise and should not be considered a ‘finding.’ Heiny (2008).” Finley and Halsey (2004) also report that greens in regulation and putts per round explain nearly all of the variation in PGA scoring, 1990-2004, that can be accounted for by the PGA tour skill measures. And, for the LPGA tour, a “one standard deviation improvement in the mean driving distance increased the annual prize earnings by about \$59,000-\$76,000, compared to about \$92,000-\$118,000 for a one standard deviation improvement in putting skill (Park and Lee, 2012).” A shortcoming of these studies using the PGA tour and LPGA tour website data is that driving distance is measured on only two holes per round. These holes are selected so that they run in opposite directions to control for wind and selected so that players are likely to hit driver.¹

In figure 1 the average driving distances on the PGA and LPGA tours are shown, by year, 1990-2012.² The graph shows four periods of change in average driving distance on the tours. Average driving distance increased at a substantial rate from 1993 through 1999, leveled off in 2000, then increased at an even greater rate than in the earlier period from 2001 through 2003, and then stopped increasing or increased very slowly after 2003. These trends mirror important changes in technology and in the rules and regulations governing professional golf. The 1990’s was the decade of technological change in the driver, led by the Callaway Golf company, which first brought to market larger headed drivers and titanium headed drivers.³ In late 1991 Callaway introduced the Big Bertha, a stainless steel driver with a 190 cc head, which was 25% larger than other drivers in use at that time. Callaway used titanium to increase the driver head another 25%, to 250 cc in 1995 (the Great Big Bertha) and to 290 cc in 1997 (Biggest Big Bertha). Other golf manufacturers followed Callaway. TaylorMade brought out a driver in 1996 with a 285 cc titanium driver head. Ping and Titleist introduced oversized titanium drivers in 1998. Cleveland Golf launched their titanium driver in 2002 and in 2003 introduced a 460 cc titanium driver head.⁴

Large driver heads and titanium driver heads appear to contribute to longer driving distance in three ways: 1. larger club heads enable more weight to be placed towards the perimeter of the club head, which could improve the distance of off-center hits (Dorman, 1994); 2. the extra strength of titanium enables club makers to manufacture thinner and larger club faces which can provide a trampoline effect at impact⁵ and 3. the extra strength of titanium enables lighter club heads which in turn enable longer shafts, both of which contribute to faster swing speeds.

It is difficult to establish the rate at which the new driver technology spread among the players. The Big Bertha was the number one driver on the LPGA tour, the Senior Tour (for players fifty and older), and the Hogan Tour (the “minor league” tour) at the end of 1992. Equipment contracts are more common on the PGA tour, which would slow diffusion. In 1995, Callaway drivers were number one on all tours, including the European PGA tour. However, Callaway could be number one with a relative small market share if there are, say, six other prominent equipment companies. Callaway company sales revenue did increase from \$55 million in 1991 to \$850 million in 1997.⁶

The United States Golf Association, golf’s ruling body in the US, responded to the new driver technology with new regulations to preserve the integrity or maintain the difficulty of their over 10,000 member courses. The USGA has regulated clubs and club head properties since the late 1800’s and has regulated properties of the ball since 1920 (USGA, 2013). To limit the “trampoline effect” the USGA set the maximum value of the coefficient of restitution of the driver face at .83, effective for 1999.⁷ This may have ended the distance premium from new driver technology. Driver heads did get larger after 1999, but not coefficients of restitution.⁸ If the pros were consistently in the sweet spot in the already oversized club heads, not much additional distance could be expected from increases in club head size. And driving distance was the same in 1999 and 2000 on the PGA and LPGA tours.

Then, in 2001, the introduction of the three piece ball apparently resulted in additional gains in driving distance. The three piece balls had a solid center but the feel and control of the liquid core wound balls (as in a ball of string) that they replaced. The Titleist three piece ball (pro V1) was probably the most consequential in that the majority of touring pros were already under contract to play Titleist balls. Eighty seven of the 156 contestants in the 2002 US Open championship, for example, used the pro V1 (Brink and Sandomir, 2002). Nearly all of the other contestants were using three piece balls from other manufacturers (Johnson, 2001). The USGA regulates golf ball size, dimples, weight, and initial velocity and distance when hit with test equipment. However, the solid center of the three piece ball apparently resulted in longer distances. In 2002, the USGA changed their testing procedure to better control distance by identifying the aerodynamic “fingerprint” of each ball and incorporating computer simulation in testing. Ball distances were now calculated at the launch angles and spin rates optimal for each ball (Thomas, 2001). The three piece balls conformed to the new standards but additional distance gains from changes in the ball appear to have ended.

Data and Results

I use piecewise regression to describe the driving distance - year trends evident in figure 1 and discussed above. I allow for different slopes in the 1993-1999, 1999-2000, 2000-2003, and 2003-2012 periods. I present random and fixed effect results, grouped on player, for both PGA and LPGA tour players. The dependent variable is average driving length in each year by each player, 1993-2012. The table 1 piecewise

regressions show the different slopes in the four periods. The differences in the slope coefficients between periods are statistically significant in all regressions. For the men, with fixed effect coefficients in parentheses and an asterisk indicating statistical significance, average driving distance increased by 2.1* (1.6*) yards per year in 1993-1999, by 1.1 (.2) yards per year 2000 – 2001, by 4.5* (3.8*) yards per year, 2001 – 2003, and by .4* (-.3*) yards per year in 2003-2012. For the women, average driving distance increased by 2.2* (1.5*) yards per year in 1993-1999, by .2 (-.8*) yards per year 2000 – 2001, by 3.0* (2.7*) yards per year, 2001 – 2003, and by -.1* (-.9*) yards per year in 2003-2012. The smaller fixed effect coefficients mean that longer drivers have crowded out shorter drivers on the tours. This could be because course setups have become more favorable to longer hitters,⁹ because improvements in instruction or training favor younger cohorts, or because “biologically” longer hitters have been attracted to golf and qualified for the tours.¹⁰ If we think of 1993-1999 as the oversized titanium driver period and 2000-2003 as the lively ball period, then the improvements in drivers impacted the men and women pros equally in terms of gains in distance,¹¹ while the livelier balls favored the faster swinging men. There is disagreement about the three piece ball - swing speed – distance relationship. Most notably, Jack Nicklaus, the leading golfer in terms of majors won and a prolific course architect has complained for sometime about the three piece ball and swing speed, which in his view requires him to design longer and more expensive courses. The USGA technical staff, on the other hand, has claimed that the idea that “modern golf balls used on the PGA tour give an unfair distance advantage to players with very high swing speeds” is not accurate. “In short, there is no extra distance ‘bonus’ for high swing speeds (Quintavalla, 2011).”¹² This may be true in terms of “changes in slope,” but figure 1 in the USGA research document shows the driving distance using titanium drivers and the three piece ball at swing speeds of 90, 110, and 125 mph to be 225, 285, and 320 yards. The average swing speed of PGA and LPGA tour pros with the driver in 2009 was reported to be 112 mph and 94 mph, respectively (Rice, 2012).¹³

Summary and Conclusion

In this paper I have examined driving distance on the PGA and LPGA tours, 1993 to 2012. I used piecewise regression to identify separate periods of change in the annual average driving distance - year relationship. These are: 1993 – 1999, 1999 – 2000, 2001 – 2003, and 2003 – 2012. I argue that improvements in the driver in the 1990s are primarily responsible for increase in driving distance in the first period and that the limitations placed on the trampoline effect of the driver face for 1999 by the USGA effectively ended the distance premium from new driver technology. Then, in 2001, the introduction of the three piece ball resulted in additional gains in driving distance until changes in testing procedures in 2003 enabled the USGA to more effectively control golf ball distance. The faster swinging men pros benefited more from the three piece ball than did the women in terms of driving distance, while each benefited equally from the improved driver technology. Fixed effect estimates indicated that there has been some crowding out of shorter drivers by longer drivers on the tours

since 1993.

¹ I used the website PGA tour annual average data for each player for adjusted score per round, driving distance, and driving accuracy over the 2003-2010 period analyzed by Brodie with the shot link data and found a relatively small distance and accuracy effect on adjusted scoring. I ran a kitchen sink regression using the annual data for each player with average adjusted score per round determined by driving distance, driving distance squared, driving accuracy, driving accuracy squared and a distance-accuracy interaction term. Results for this specification should overstate the importance of driving distance and accuracy to the extent they are positively correlated with other skill measures which also favorably impact scoring, such as greens in regulation. Brodie's table 2 shows Tiger Woods and Vijay Singh to be the the tour leaders in strokes gained per round from the long game (shots over 100 yards) and that Woods and Singh gained .7 strokes and .8 strokes per round, respectively, because of their tee shot proficiency on par 4s and 5s relative to their peers. The predicted score from my kitchen sink model for Woods is .2 strokes lower than the average score for all players, 70.84 as compared to the average of 71.01, and .1 stroke lower than the average for Singh. Woods' average adjusted score was 68.34 in the period and Singh's was 69.53. These results are consistent with the idea that skill measures other than driving distance and accuracy are more important determinants of scoring than the driving variables. The fourth ranked long game player in the shot link data, Ernie Els, who gained .6 strokes per round on tee shots, actually has a higher predicted score than the average score in my regression model. Also, the R squared of my kitchen sink model is only .06 whereas the R squareds of the models reviewed above using the distance and accuracy variables plus the other set of skill variables run up to .8. Recall again, however, that all of these results based on the PGA and LPGA tour website data are taking driving distance from only two holes per round whereas the shot link data is taking account of distance on all tee shots on par 4s and 5s. Furthermore, many players in the 2003-2010 period no longer used driver on a significant portion of the par 4s and par 5s.

² Data on driving distances for LPGA tour players are not available until 1993.

³ In 1999 one of the top course designers, Rees Jones, said that the turning point on dog legs on his courses had been increased from 250 yards to 280 because of improvements in the driver (Heiny, 2008). In 1997, Frank Thomas, technical director, USGA, asserted, "There has been very little improvement in the aerodynamic performance of the golf ball in the last 10 years (Schiesel, 1997)."

⁴ Data cited in this paragraph from the golf company websites.

⁵ "The clubface deforms slightly upon impact with the ball, due to the elastic property of the thin (titanium) metal. The clubface then quickly rebounds to give the ball added punch (Gromer, 2003)."

⁶ All data in this paragraph from the Callaway Golf website.

⁷ The USGA limited the maximum size of the driver head to 460 cc, effective for 2003.

⁸ Callaway had developed its ERC titanium driver for 1999, which had the greatest trampoline effect in its product line, but it was judged non conforming by the USGA under the new regulations.

⁹ For example, the yardage at Mission Hills, home of the Dinah Shore and a LPGA tour major, was increased from 6,446 to 6,738, 1994-2013. And the yardage at Augusta National, home of the Masters, was increased from 6,925 to 7,435, 1994-2012.

¹⁰ Average height increased from 71.4 inches in 1993 to 71.8 inches in 2012 on the PGA tour and average age decreased from 34.8 years to 34.6 years. On the LPGA tour the height of American players increased from 66.6 inches to 67.0 and their average age decreased from 32.2 to 30.1. Height is positively associated with distance and age negatively associated in variable effects driving distance models that also include year, although the changes in means coupled with the marginal effects imply changes of only a couple of yards in distance. For all participants on the LPGA tour, height decreased from 66.6 to 66.3 during the period, as the tour became more Asian, and age decreased from 31.8 years to 29.7.

¹¹ Driving distance increased 12 yards, 1993-1999, on both tours. Two possible explanations for why women pros gained *proportionately* more distance are that the women were less likely to find the sweet spot in the smaller driver head era than were the men or that the women increased shaft length and thus, club head speed, proportionately more than did the men.

¹² Jack Nicklaus in 2003: "It's ridiculous. Absolutely ridiculous... And the way they test golf balls, they monitor tests at 110 miles an hour. I swing at 110 miles an hour, I can't make the golf ball go anyplace. If you swing at 110 to 130 miles an hour, it's like the difference between a category 2 and category 3 hurricane. It's not a little bit. (The golf ball) just explodes." (Coate and Goldbaum, 2004). Also, Benard Langer, past Masters Champion and multiple winner on PGA and Senior PGA tours, in 2012: "I think what happened is when we switched from the balata wound ball to the two- or three-piece balls, whatever they are now, if you swing the club 10 miles faster than the other guy, you used to get about 10 yards for every mile about a yard. Now if you swing it 10 miles faster, you get about 20 to 25. So the guys who swing it faster or harder have, you know, even more of an advantage, and that's where these tremendous distances come from. (Stachura, 2012)."

¹³ The 18 mph swing speed advantage of the men would give them about 40 yards more distance according to Langer's opinion in note 16 ($1.8 * 22.5$) and would also give about 40 more yards according to Quintavalla, 2011, figure 1. Average driving distance on the LPGA and PGA tour was 250 and 290 yards in 2012.

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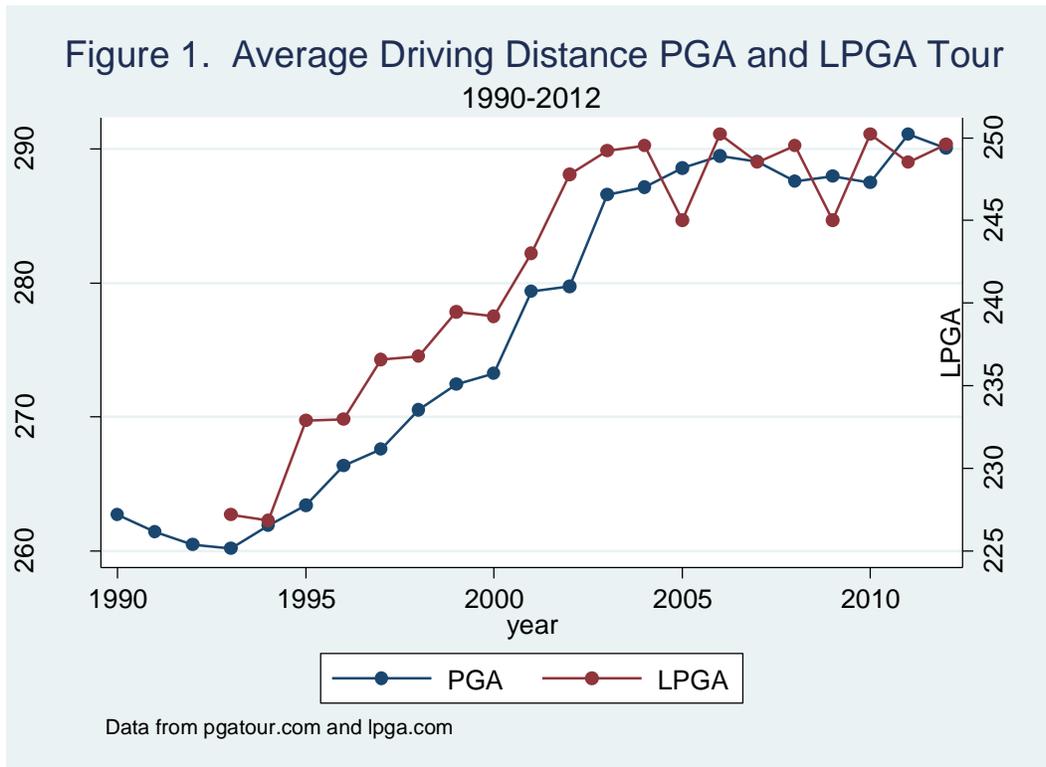


Table 1. Piecewise Regression Results for Driving Distance for the PGA and LPGA Tours, 1993-2012

	PGA1	PGA2	LPGA1	LPGA2
P9399	2.08	1.61	2.16	1.51
	18.32	27.45	15.21	20.41
P9900	1.06	0.15	0.18	-0.78
	1.67	0.50	0.23	-1.98
P0003	4.48	3.82	3.01	2.66
	21.2	36.58	11.23	19.18
P0312	0.35	-0.31	-0.10	-0.93
	5.65	-8.82	-17.11	-1.81
Player Dummies		yes		yes
Constant	-3893.5	-2954.11	-4068.89	-2758.09
	-17.15	-25.11	-14.41	-18.75
Rsquared	0.62	0.94	0.38	0.86
N	3841	3841	3016	3016

Note: Periods are 1993-1999, 1999-2001, 2001-2003, 2003-2012. The dependent variable is average driving distance for each player for each year. Thus, a player who competed in each year, 1993-2012, would provide 20 observations. t statistics below coefficients. Data from pgatour.com and lpga.com.

